Orthotics Measurement Board for Tibial Torsion and Toe-Out

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COORDINATED function of the brace-anatomical complex is dependent upon the configuration and fit of the brace with the patient's anatomical structure. Brace alignment should be consistent with individual variations in toe-out and tibiofibular torsion. The process of accomplishing such proper alignment depends, first, upon the anatomical measurement technique and, second, upon the orthotic fabrication technique.

Since, in conventional orthotics practice, individual tibial torsion and toe-out accommodations are rarely made for lack of precise measuring devices and techniques, an orthotics measurement board was devised at New York University.[3] The measurement board was designed to obtain individual measurements of tibial torsion and toe-out as well as to serve as a tracing board. In addition, a technique was developed by which the measurements obtained through the use of the orthotics measurement board can be utilized to make appropriate accommodations for tibial torsion and toe-out in the patient's brace.

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[3] The measuring device is obtainable from the Pope Foundation, 197 South West Ave., Kankakee, Ill. 60901.

DESCRIPTION OF MEASUREMENT BOARD

The measurement board (Fig, 1) consists of two hinged masonite boards, an adjustable footrest permitting vertical adjustment as well as rotational adjustment on the goniometer, and two malleolar pointers mounted on the footrest, which is slotted to allow anteroposterior adjustability of the pointers. Mediolateral adjustability is provided by a set screw locking the malleolar pointers in the desired position.

MEASUREMENT PROCEDURE

Prior to positioning the patient on the measurement board, the medial and lateral malleoli are marked on the patient's skin to serve as landmarks for the determination of tibiofibular torsion. On the assumption that the ankle-joint axis runs through the centers of the malleoli as viewed in the sagittal plane, the width of each malleolus is palpated and its center indicated by a mark approximately one-half-inch long.

PATIENT PLACEMENT

Placement of the patient on the measurement board is one of the most critical parts of the procedure. The patient must be seated on a hard-surfaced table with both knees flexed approximately 90 deg. over the edge of the table and with the measurement board placed under the involved extremity (Fig. 2). The popliteal areas should be pressed firmly against the hinge of the measurement board on the affected extremity and against the edge of the table on the sound leg. This ensures that the knee axis runs parallel to the hinge of the board. The space between the knees in this position should not be excessive, for this would influence the accuracy of the measurements. At this point, the footrest should not touch the pa-

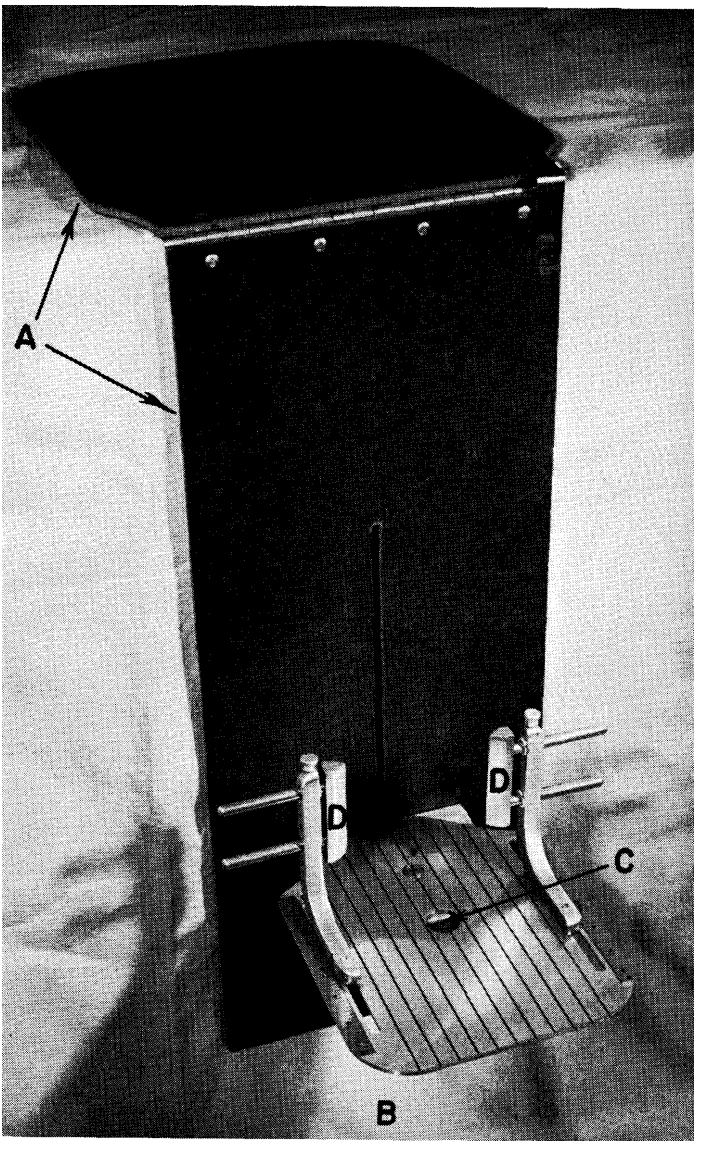


Fig. 1. Device developed at New York University for measurement of tibial torsion and toe-out. Components are two hinged masonite boards *A*, an adjustable footrest *B*, permitting vertical adjustment as well as rotational adjustment on the goniometer *C*, and two malleolar pointers *D* mounted on the footrest *B*, which is slotted to allow anteroposterior adjustability of the pointers.

tient's foot; thus the weight of the shank is allowed to orient the knee axis horizontally in the frontal plane.

TIBIAL TORSION

The procedure described does not involve any angular measurement of tibial torsion, because the relative anteroposterior distance between the medial and lateral malleoli in the transverse plane is a simpler measure for orthotics application.

Following the proper placement of the patient on the measurement board, the f ootrest is brought against the patient's foot. Care must

be taken that the foot is not distorted in any way as the footrest approaches the foot; that is, the foot should not be everted or inverted. To measure the amount of tibial torsion, the goniometer setting must be at the zero mark. This places the adjustment slots in the footrest at right angles to the surface of the masonite board. With the back of the patient's heel pressed against the board, the malleolar pointers are individually adjusted to coincide with the landmarks previously indicated on the patient's skin (Fig. 3). The scale on either side of the footrest measures the distance of the medial and lateral malleoli from the back of the heel. These two measurements are then recorded on the orthotics measurement form (Fig. 4). (See Appendix A.)

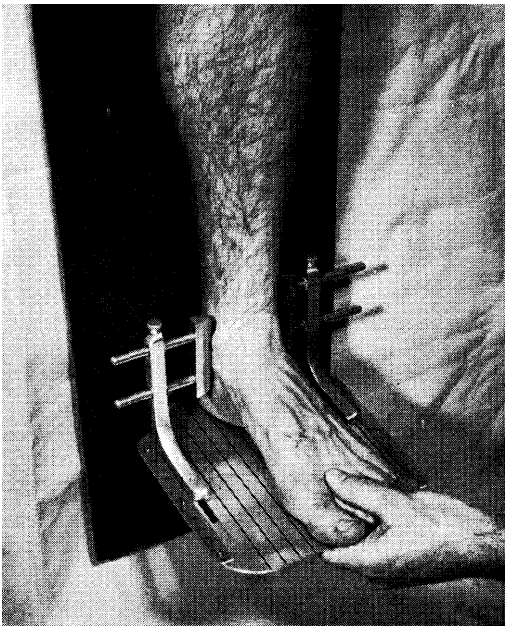


Fig. 3. Measuring tibial torsion.

TOE-OUT

Toe-out is measured by carefully lifting the patient's foot slightly away from the footrest so as to permit the footrest to rotate about the goniometer. The footrest is adjusted until one of the longitudinally inscribed marks coincides with the medial border of the foot (Fig. 5). It should be noted that the orthotics measurement board does not measure the degree of toe-out as related to the long axis of the foot; rather, it measures the angular relationship between the medial border of the foot and the knee axis. This measure is also recorded on the orthotics measurement form.

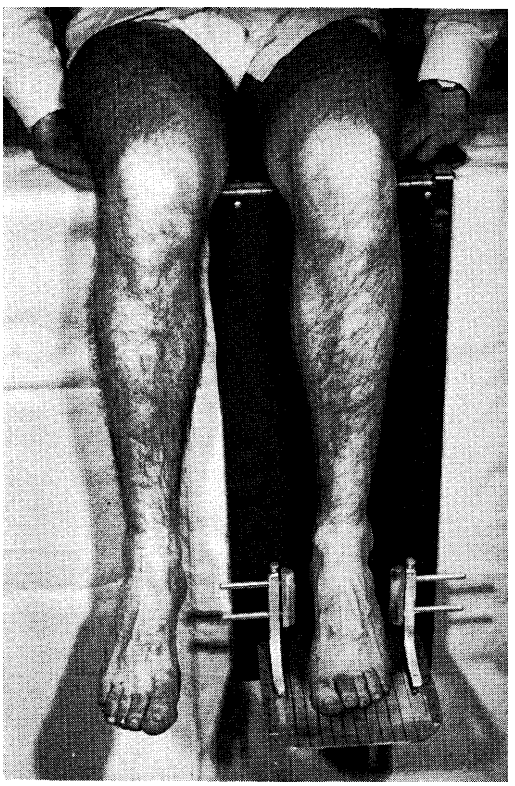


Fig. 2. Positioning patient on orthotics measurement board.

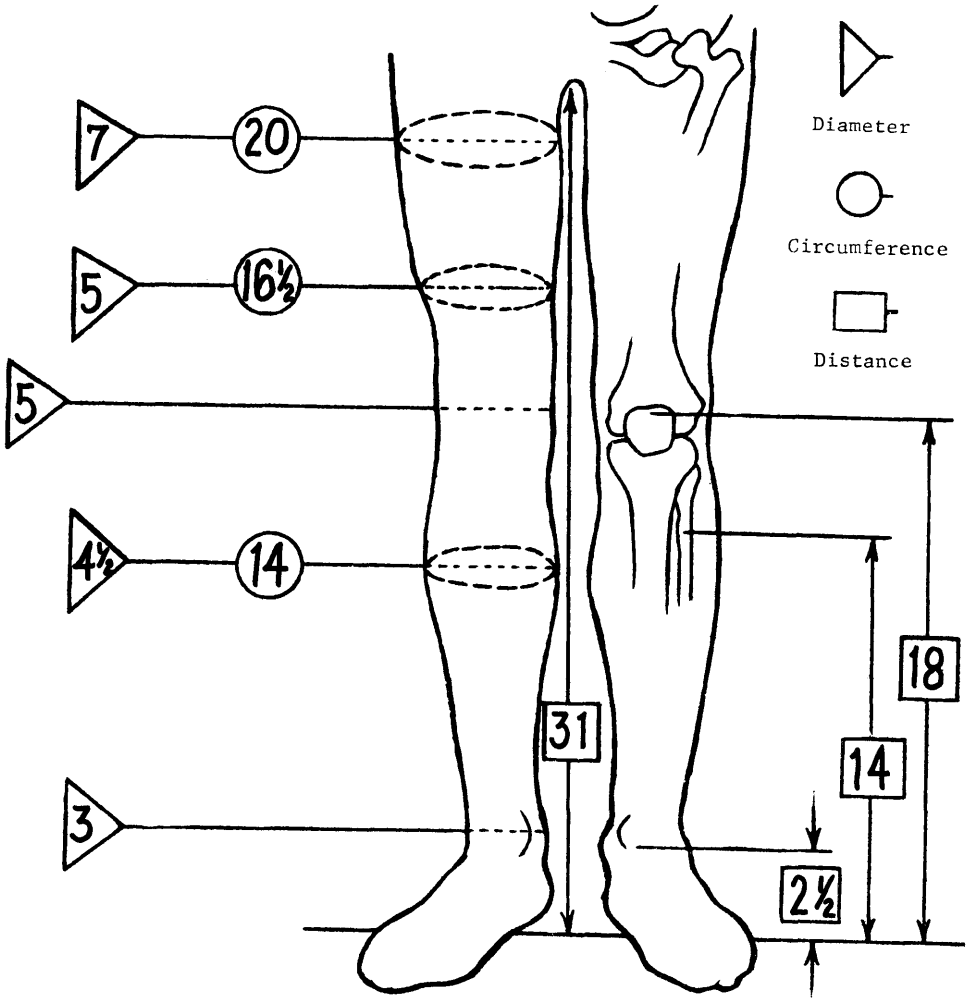
FABRICATION PROCEDURE

TIBIAL TORSION

From the measurements obtained, it is a relatively simple procedure to introduce tibial torsion into the brace. The difference between the medial and lateral malleolar measurements simply indicates the amount of offset needed between the medial and lateral brace ankle joints. If, for example, the medial malleolar measurement is 3 in. and the lateral measurement is 2 in., the difference is 1 in. Therefore, the medial ankle joint is offset anteriorly with respect to the lateral ankle joint by 1 in. plus % in. for a total of l^fj in. (Fig. 6). The purpose of the additional }/% in. is to allow for the

usual clearance needed between the malleoli and the brace ankle joints.

Generally, the offset is made on the medial bar if the difference between the malleolar measurements is 1 in. or less because, normally, the medial malleolus is anterior to the midline of the leg as viewed in the sagittal plane. Should the difference of the malleolar measure-



Degree of Toe-Out 12° Shoe Size 9D

Measured On:

Medial Border ✓

Lateral Border

Tibial Torsion

Distance to Medial Malleolus 3" Distance to Lateral Malleolus 2"

Fig. 4. Lower-extremity orthotics measurement form.

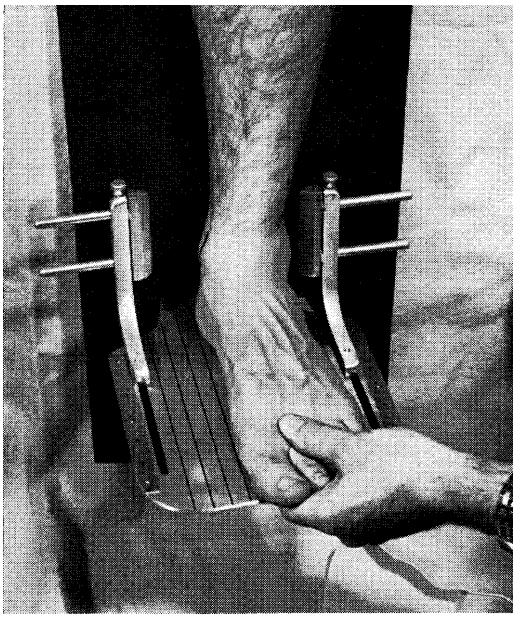


Fig. 5. Measuring toe-out.

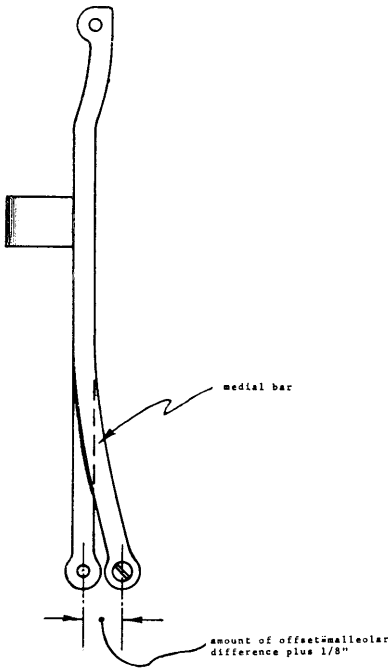


Fig. 6. Accommodation for tibial torsion on the medial bar of the leg brace when the difference between malleolar measurements is 1 in. or less.

ments exceed 1 in., the excess is accommodated by posterior deflection of the lateral ankle joint. After offsetting the ankle joint, both joint surfaces must be realigned parallel to each other (Fig. 7).

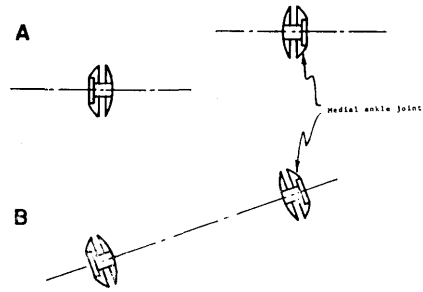


Fig. 7. Accommodation for tibial torsion by anterior deflection of the medial ankle joint of the leg brace. When the difference between the malleolar measurements exceeds 1 in., the lateral joint is posteriorly deflected by the excess over 1 in. *A,* Before parallel realignment of joint surfaces; *B,* after parallel realignment of joint surfaces.

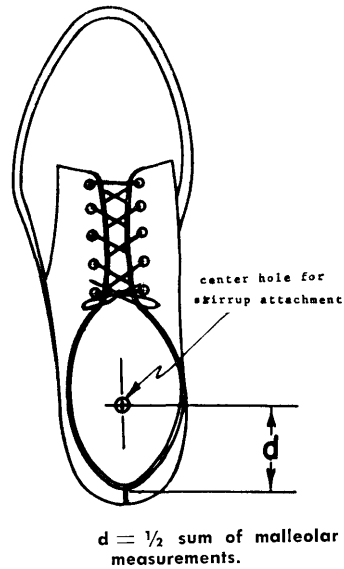


Fig. 8. Accommodation for toe-out. A hole is drilled through the sole of the shoe at a point in front of the counter, equal to one-half the sum of both malleolar measurements.

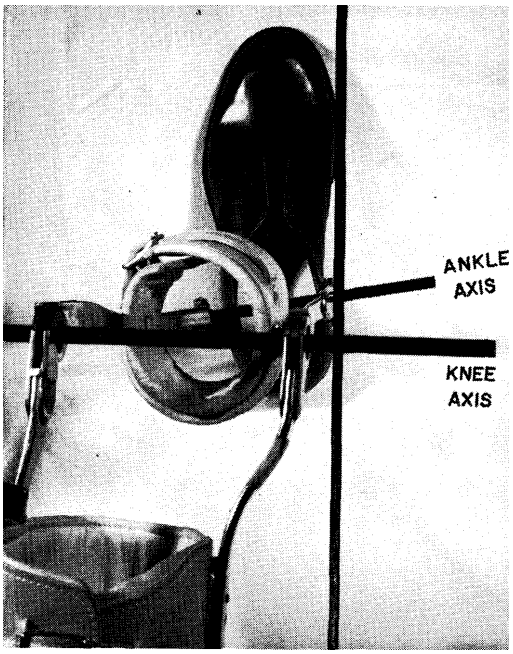


Fig. 9. Relating toe-out to the knee axis of the brace.

TOE-OUT

Toe-out accommodation is the final step in brace fabrication. This requires assembly of the stirrup to the leg brace frame. To determine the proper anteroposterior position of the stirrup on the shoe, a hole is drilled through the sole of the shoe at a point in front of the counter, equal to one-half the sum of both malleolar measurements (Fig. 8). The stirrup is then attached to the shoe with one rivet through the center of the stirrup to permit rotation of the shoe on the stirrup to match the degree of toe-out recorded on the orthotics measurement form. As described in this article, toe-out is measured as the angular relationship between the knee axis and the medial border of the foot. Consequently, in brace fabrication the medial border of the shoe must be related to the brace knee axis (Fig. 9). Two or more additional rivets may then be used to fix the shoe on the stirrup in the desired position.

SUMMARY

The measurement board described is designed to measure the relative distance of the medial and lateral malleoli from the back of the heel in the transverse plane. It is also used to obtain an angular measurement between the medial border of the foot and the knee axis.

Following the procedure described, the orthotist may produce a brace which more nearly corresponds to the patient's individual anatomical structure. Although the accommodation of tibial torsion is of diminished consequence when limited-motion ankle joints are used, its routine introduction in the brace is relatively simple and, of course, of utmost importance with free-motion ankle joints. Conversely, toe-out accommodation is not dependent on the type of ankle joint but is an individual measure with equal importance in all cases.

ACKNOWLEDGMENTS

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